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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Rock Crushing Machines

Screen Design and Lubrication

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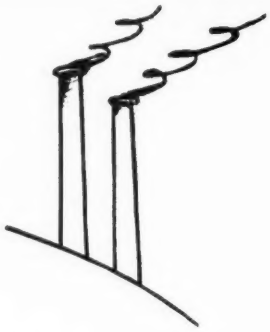

Reducing Power Consumption by Means of Oil

IN THE past when the cost of power consumed could be readily passed on to the ultimate consumer, nobody worried. But when production costs came to be studied and competition became keener at reduced prices, the power bill received its due consideration along with all the other items of plant expense. Then followed the more forcible realization that power consumption was contingent upon lubrication, and the methods of maintaining lubrication.

We, of The Texas Company, early realizing this fact, set about to improve the dependability of our lubricating oils and greases to such an extent that those who used them would obtain a noticeable reduction in power consumption. We entered the lists with a program of research, especially noteworthy for its intensity. This policy has proved the value of absolute cooperation between research and technical lubrication service. Our research authorities are never approached until lubricating conditions prevailing have been developed by the practical personnel of our technical staff.

This is why we are able to offer builders and operators of heavy duty machinery, as used in the rock products and mining industries, a series of lubricating oils and greases which have proved their ability to reduce power consumption, decrease maintenance costs and make possible more dependable production schedules.

THE TEXAS COMPANY
Texaco Petroleum Products

LUBRICATION

A Technical Publication Devoted to the Selection and Use of Lubricants

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Rock Crushing Machines

The Trend Toward Automatic Lubrication

CERTAIN industries require the use of massive, heavy duty machinery. On equipment of this type the importance of lubrication as an adjunct to reduced maintenance costs has oftentimes been given far too little consideration. Production, even at the expense of wear and tear, used to be the ultimate goal. In the past, lubrication might also have been sometimes regarded as of secondary importance, due to the shortcomings of the methods available for application.

Times of depression, however, have wrought considerable change. Builders of lubricating equipment have studied the requirements of heavy duty machinery more actively than ever before as an added field of service for their product. Designing engineers have analyzed bearing construction, and developed means to facilitate retention and circulation of lubricants; operators have shown greater interest in availing themselves of the cooperation of capable lubricating engineers; and the petroleum industry has kept pace by extending their research facilities accordingly.

The rock products industry has profited markedly by this realization of the importance of lubrication, and the progressive attitude of certain builders of rock crushing machinery. The results of their studies are worthy of detailed discussion along with the operating conditions involved.

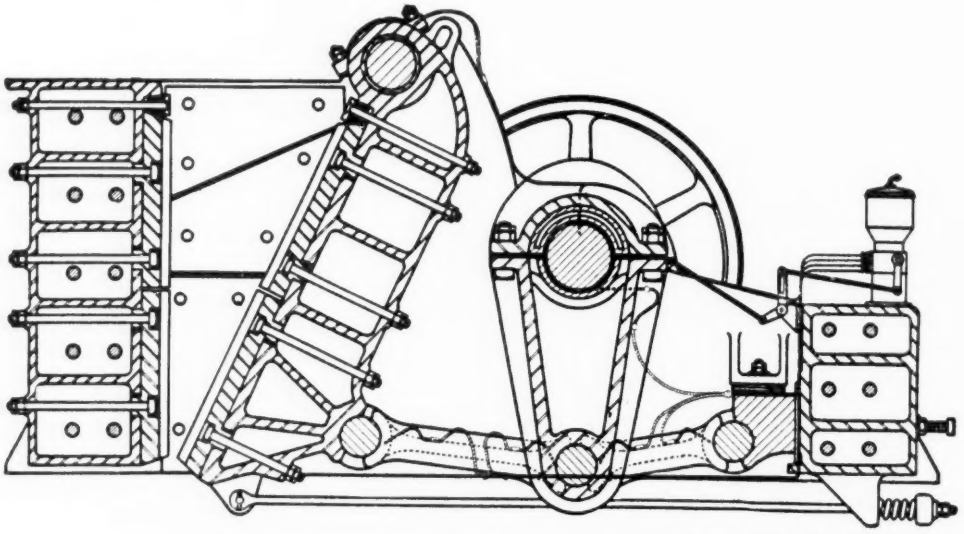
Two distinctive types of operation are involved, for the raw product must first be crushed on heavy duty machinery after which grinding or even pulverization to carefully controlled size is necessary. The preliminary work is done by jaw crushers, gyratories or roll crushers. Various types of roll, ball or tube mills are used for finishing the crushing operation.

JAW CRUSHERS

Rock and ore as blasted from the quarry or mine are effectively reduced in size of lumps by jaw crushers or gyratory crushers with large feed openings, this operation being termed primary breaking. A jaw crusher may be briefly described as a machine with a hollow, rectangular frame, having a renewable breaking plate or die fixed in one end and a lever or swinging jaw to which is attached a similar renewable breaking plate. The fixed die is vertical, while the swinging jaw is set at an angle to the fixed die and is arranged to swing backward and forward at regular intervals and considerable speed, so as to impinge upon the mass of rock introduced in the opening between the two dies, in order to accomplish crushing. Thus, a large lump of rock, introduced at the top of the opening, gradually is made smaller by repeated blows of the swinging jaw until it is finally broken into pieces small enough to permit passage through the discharge opening. The crushing surfaces of both the fixed and moving dies are usually corrugated, but the machine

works equally as well if these corrugations are omitted.

The motion of the swinging jaw is accomplished through the agency of a second moving member, called a pitman, which is suspended from bearings integral with the frame and



Courtesy of Pennsylvania Crusher Co.

Fig. 1—Sectional view of Pennsylvania-Buchanan primary jaw crusher. This machine has provision for pressure grease lubrication of all bearings. The lubricator is shown located to the right on the rear frame head, with piping leading therefrom to all bearings as indicated. The lubricator itself is actuated from the pitman through a ball crank and connecting rod.

located about midway between the swinging jaw and rear of the frame. The pitman has a vertical rolling motion due to the revolution of its eccentric shaft, which motion is transferred horizontally to the swinging jaw by the double knuckle action of two flat plates with rounded ends, known as toggles, which engage the back of the swinging jaw, both front and rear of the pitman and the back of the frame, the toggles being held in the proper position by the weight of the swinging jaw.

Sleeve type bearings are extensively used in jaw crusher design, due to their adaptability to pressure lubrication, water cooling, distribution of pressures and reduction of these latter by increase in bearing areas. Grease seals and flexible dust seals can also be readily applied to this type of bearing, to assure of prevention of contamination of the lubricant and maintenance of pressure on the latter by reducing the tendency towards leakage. This is distinctly important in the lubrication of heavy duty machinery where lubrication under pressure must be depended upon to partially counteract the mechanical pressure on the contact parts, which is built up during operation. This in turn also leads to reduced power consumption.

The bearings of the pitman and eccentric shaft on the average jaw crusher require very careful attention with regard to lubrication. The former carry the pitman or heavy steel casting which oscillates with its bearing as the point of suspension to bring about the requisite degree of crushing, by the reciprocating motion of the swing jaw. Very frequently the pitman bearing is water-cooled; in addition, in certain large crushers it is relieved of much of the weight by the use of links and coiled springs, for the potential friction involved is considerable.

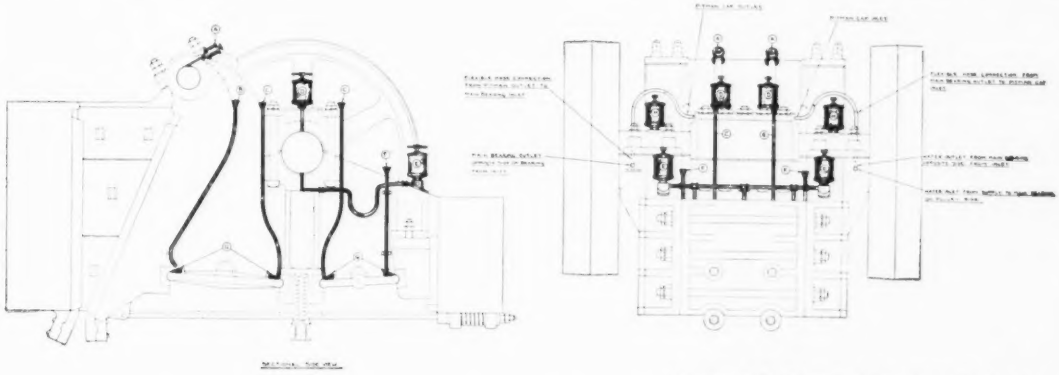
In the lubricating of this bearing, grease is very often the most adaptable lubricant. It can be applied to the bearing either by means of pressure lubricators or from reservoirs equipped with wool waste or some other form of pad retainer to insure positive lubrication without undue loss.

Where pressure lubrication is employed, a medium to heavy grease will frequently serve the purpose. The use of wool or pad lubrication, however, will require a thinner lubricant, relatively fluid in consistency, in order to enable proper penetration of the wool. When wool waste is used a metal screen should be placed in the bottom of the reservoir to prevent strands of wool from working into the bearing.

Regardless of the means of application, it is, of course, obvious that the lubricant must be capable of reaching the lower wearing surfaces where pressure and friction will be the greatest. To more safely insure this, certain builders provide for delivery of grease (under pressure) to both the top and bottom of the bearings.

Lubrication of the eccentric bearings must also be carefully controlled, due to the potential loads which may have to be carried. Unless the

weight of the pitman is more or less balanced by springs, etc., its weight will be exerted upon the eccentric shaft bearings, with the probable result that the lubricant will be unable to penetrate and maintain the requisite friction-reducing film between the shaft and bearings.



Courtesy of Birdsboro Steel Foundry & Machine Co.

Fig. 2—Lubricating chart for the Buchanan type "C" crusher, also showing means for water cooling (a) indicates swing jaw shaft provided for grease lubrication, (b) swing jaw toggle bearing oil lubricated, (c) pitman toggle bearing oil lubricated, (d) grease cups for upper half of pitman bearings, (e) grease cups for lower half of same bearing, (f) the tail piece toggle bearing oil lubricated, (g) waste packed recesses in toggles, (h) the eccentric shaft frame bearing grease lubricated.

The construction of the crusher must, therefore, always be taken into consideration. Where springs and links are used to balance the pitman, reservoir pad lubrication using a light grease will probably work out satisfactorily. Where the weight of the pitman is carried on the eccentric bearings, as well as on its own supports, pressure lubrication with a heavier grease will be more positive. Constant pressure on the grease is a distinct adjunct to effective lubrication in such service.

Toggle seats may or may not require lubrication, all according to the nature of their construction. Where rolling motion prevails, it is claimed that the need for lubrication is eliminated. Certain types, however, will involve sliding friction at the toggle seats. In such cases oil lubrication is usually provided for by the builders by means of suitable drip cups. For this purpose a relatively heavy machine oil will serve the purpose.

OPERATION OF THE GYRATORY

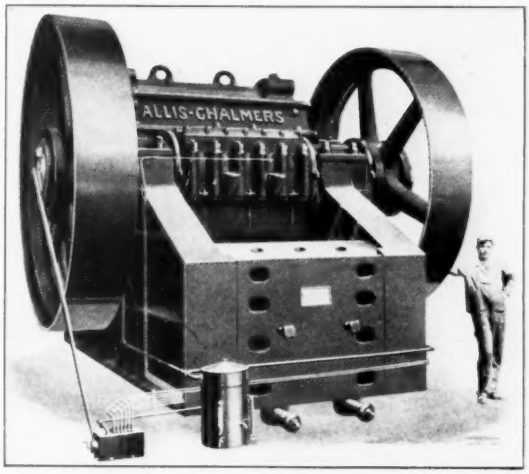
Crushing is brought about in the gyratory by the circular rolling motion of the crushing head, which is actuated by gearing or belt drive through an eccentric at the bottom of the shaft. By this action the head receives circular rolling motion, successively approaching every point of the interior of the throat. This action results in a continuous breaking of the material which subsequently falls through at that point of the throat from which the head is most distant.

A gyratory crusher will frequently be misleading as to the extent to which its operation depends upon lubrication. Many will be led to believe that this latter is a relatively simple matter. This is far from true, however. In fact, due to the peculiarities of construction, and the heavy duty involved, gyratory lubrication is oftentimes a matter of considerable difficulty. Not only are the bearings frequently exposed to a great deal of grit and dust, but some of them also carry tremendous loads and occasionally are subject to wide temperature variation.

Construction details

There are two types of gyratory crushers, viz.:

(a) the geared drive
(b) the gearless type



Courtesy of Allis-Chalmers Manufacturing Co.

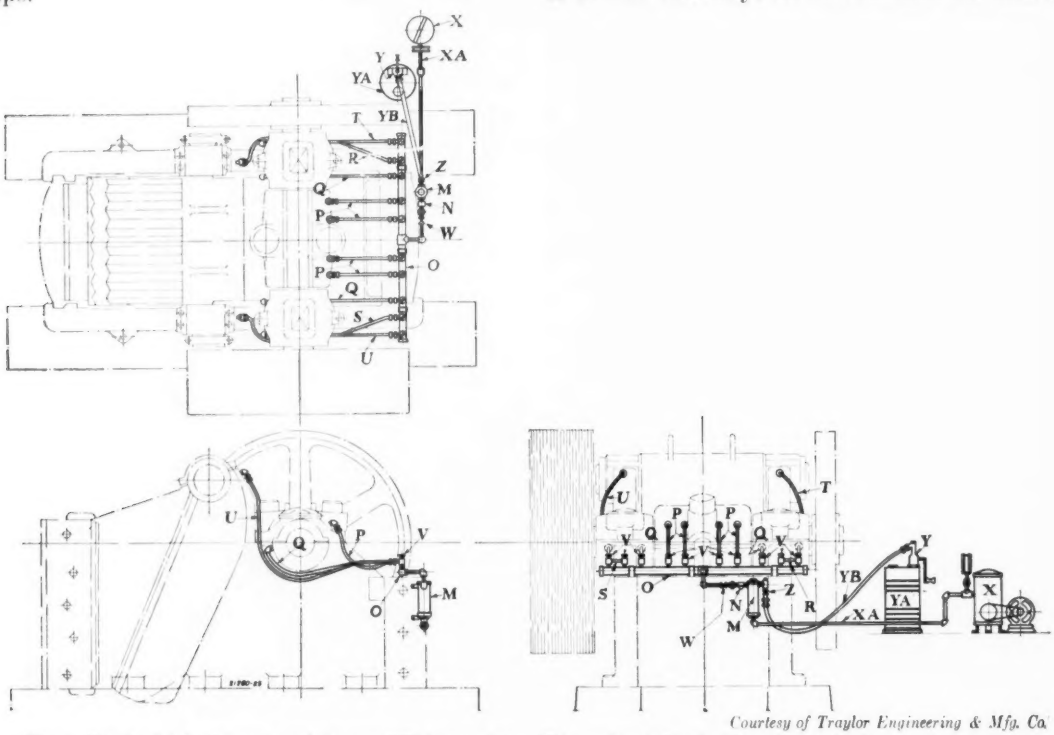
Fig. 3—View of Allis-Chalmers jaw crusher, showing force feed oiling system consisting of an oil pump, reservoir and filter operated from one end of the pitman shaft.

Lubrication of the gear driven crusher is more involved than the gearless drive, due to the use of gears, and counter shaft bearings. The latter are occasionally of the ring-oiled type, but be-

cause of the loads which they are forced to carry, to say nothing of the grit which gets into the bearings, this is oftentimes an unnecessary refinement. The speed of such bearings rarely exceeds 600 R.P.M. and consequently they can be quite adequately lubricated with oil or grease cups.

fitted about the shaft where it enters the gear case and all openings are covered, but despite all these precautions a certain amount of dust will find its way into the gear case, to contaminate the gear lubricant.

This latter must, therefore, not be too thin or low in viscosity, for in this case the film de-



Courtesy of Traylor Engineering & Mfg. Co.

Fig. 4—Showing lubrication system of the type "G" jaw crusher. This machine is fitted with a self-contained constant pressure, automatic grease lubricating system. Grease is supplied to the distributor (M) from drum (YA) by hand operated pump (Y). The essential piping from the point of supply is plainly indicated.

There is, of course, a decided advantage to the ring oiled bearing, by reason of the washing action developed in the oil. Consequently, any dirt or grit will normally be washed from the journal and carried into the reservoir. This latter, on the other hand, must be of adequate capacity. Furthermore, it must be cleaned frequently, otherwise grit may accumulate, ultimately to result in serious abrasion of the journal or bearing.

Wherever possible, countershafts should be fitted with outboard bearings, as these steady the shaft and take a great deal of load off the main bearing. A heavy engine or machine oil with a viscosity range of from 500 to 750 seconds Saybolt at 100 degrees Fahr., will usually prove successful in the average countershaft bearing of a gyratory crusher. For cold weather service the oil must have a sufficiently low pour test in order that it may flow readily at the prevailing operating temperatures.

Gear Lubrication

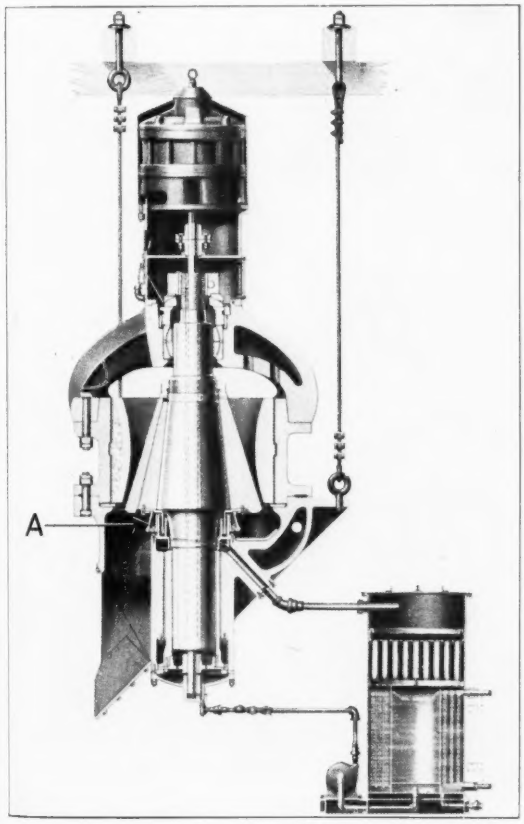
In the gear driven gyratory the gears are subjected to very hard service. Dust rings are

veloped on the gear teeth will not have sufficient body to prevent grit from coming into actual contact with the gear teeth as they pass into mesh. This, of course, would lead to abrasion and wear. As a result, the lubricant used upon these gears should be carefully selected. A straight mineral oil of from 90 to 140 seconds Saybolt at 210 degrees Fahr., will usually give the best results. It will furthermore resist the drying action of the dust and prevent its packing between the teeth of the gears, thus obviating any tendency in the latter to spring and throw unnecessary pressure upon the countershaft bearings and the eccentric. Where a crusher may have to operate in cold weather, the lubricant used upon the gears must also have a low pour test to insure proper fluidity in the oil. This will reduce drag, power consumption and the possibility of abnormal wear of the gear teeth.

Function and Lubrication of the Eccentric

The function of the eccentric in the operation of a gyratory is distinctive in that it develops

the necessary gyratory motion for the main shaft. This must be maintained at a uniform rate in the interest of maximum crushing ability with minimum power consumption. Lubrication must, therefore, be most carefully studied. As the eccentric revolves within a bushing and about a shaft, there are two surfaces to be lubricated. In addition, there is the brass wearing ring which carries the weight of the bevel gear and eccentric. In some machines the base of the machine is also designed to fit loosely in the eccentric to facilitate tipping from side to side. This action may lead to serious overheating and wear unless adequate lubrication is maintained, for all the pressure will be periodically imposed upon a comparatively small area near the top of the thickest part of the eccentric sleeve.



Courtesy of Allis-Chalmers Manufacturing Co.

Fig. 5—Cut-away view of the style "B" Newhouse crusher, showing details of the oiling system. The eccentric is automatically lubricated by filtered and cool oil supplied by this system. The top journal and suspension device are independently oiled. (A) indicates a hard rubber oil seal which prevents leakage of oil and entry of dust or water into the eccentric bearing.

For this reason, automatic lubrication has become practically standard. Oil is delivered under positive and constant pressure to these mechanisms. Flood lubrication of this type is distinctly advantageous for not only does the oil aid in removal of heat, but the pressure under which it is circulated also tends to somewhat counteract the mechanical pressure developed on the wearing surfaces when the machine is in operation.

Oil circulation is maintained by means of a suitable oil pump or other device which is located at the bottom of the crusher, either within or adjacent to the oil reservoir or chamber in the bottom plate. An ample supply of oil is contained in the system, which as a rule includes a suitable filter or strainer through which the oil passes at each circulation. This, together with the general dust-proof construction of the modern gyratory, insures against the entry and circulation of an excess of dust through the system. As a result, all the lower wearing parts are served with a flood of clean, cool oil throughout the period of operation of the gyratory crusher, for by virtue of the nature of the design and construction, the oil pump starts simultaneously with the latter, operating at a speed commensurate with the rate of crushing.

Cooling and Heating Coils

The modern gyratory crusher is also provided with means for oil temperature control in the form of suitable coils through which hot or cold water can be circulated as necessary. Under normal conditions of crushing, provided the system has an ample oil capacity, overheating will not usually present any difficulty. Where hard rock is to be crushed, however, especially during very hot weather, or in event of using too viscous an oil, it will be found advantageous to provide for cooling the oil during its circulation. To enable this the builders of certain crushers install a water cooling coil in the oil chamber itself. Such coils can also be used for heating in cold weather to facilitate starting and decrease frictional drag within the oil by reducing the viscosity sufficiently to enable ready pumping.

Bath Lubrication

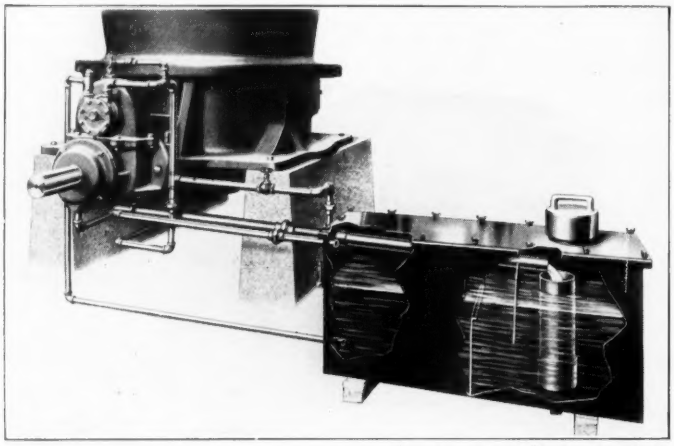
The eccentric sleeve may also operate wholly or partially in a bath of oil, which serves both as a lubricant and a cooling agent. Where no oil pressure is involved, the crusher speed is relied upon to induce oil circulation by capillary attraction, the oil passing up through the eccentric journal over the brass wearing ring and back through the passages to the reservoir beneath the shaft.

This simple oiling system has been found very efficient provided a little fresh oil is added once or twice a day to make up for that lost. The reservoir should be drained and cleaned regularly, however, to insure removal of accumulations of foreign matter.

Choice of Oil Based on Temperature

Under normal temperature conditions lubrication of the average gyratory can be effected with a straight mineral oil of from 90 to 140 seconds Saybolt viscosity at 210 degrees Fahr.

In cold weather, however, it will always be advisable to resort to an oil of lower viscosity, especially if there is no provision in the system for heating the oil prior to starting or during operation. Usually a viscosity of from 500 to 750 seconds Saybolt at 100 degrees Fahr. will be best, according to the necessity for low pour test and adequate fluidity, especially on starting.



Courtesy of Smith Engineering Works

Fig. 6—Showing lubricating system for the Telsmith primary crusher. Note large size oil reservoir, which is equipped with a strainer and baffle plates to assure of settlement and removal of dust and dirt. The oil pump which takes oil from storage and circulates it throughout the machine is located at the base of the machine. Piping to and from pump and storage is plainly shown.

Top Bearings and Rings

The spider at the top of the main shaft of the average gyratory carries the top bearings, and the suspension or wearing rings. These must also be very carefully lubricated by an oil which will not run prematurely through the bearings to perhaps leave their surfaces susceptible to excessive friction and wear. As a general rule, a straight mineral crusher oil of about 140 seconds Saybolt viscosity at 210 degrees Fahr., will meet the requirements and assure of adequate lubrication.

To facilitate the retention of the oil, the space within the cap can be packed with a pad of wool waste saturated in the lubricant. This should last for a considerable period of time provided that a small quantity of fresh oil is added every day or two via the oil hole in the spider cap.

VERTICAL RING MACHINES

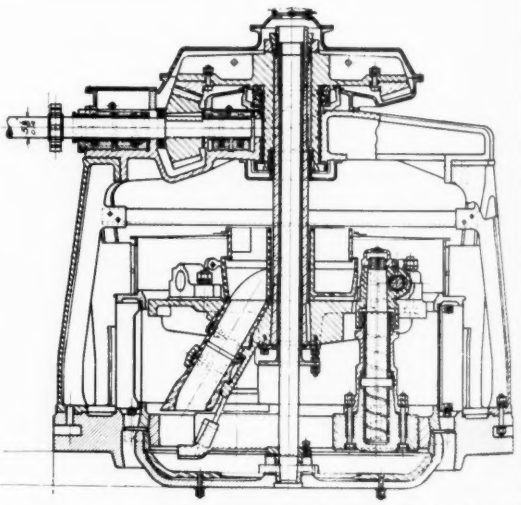
In addition to mills which grind upon a horizontal anvil ring with grinding pressure derived through centrifugal action, consideration must also be given to those machines which grind upon a vertical ring with their grinding pressure obtained from springs.

In such mills, a steel anvil ring is supported and revolved by a large horizontal gear driven shaft. Against the inner surface of this anvil ring hammer rolls are held by means of springs. The material to be ground is delivered to the anvil ring through a spout being held upon the surface of the ring by centrifugal force.

The material is pulverized as it passes between the rings and the rolls, being subsequently thrown to the hopper at the bottom of the machine. From this point the product is conveyed to external screens where all over-size particles are separated and returned to the mill for further reduction. The hammer roll bearings, the ring shaft bearings, the pinion shaft bearings and the teeth of the gears comprise the various parts which require lubrication.

Hammer Rolls

These elements are frequently mounted upon roller bearings, being enclosed in dust-proof housings. These bearings normally operate in a bath of oil, the oil being fed from a large reservoir fixed to the end of the hammer roll shaft. The oil to use for this purpose should be a straight mineral product, of sufficient viscosity to insure adequate body and the prevention of metallic contact at the operating tem-



Courtesy of Bradley Pulverizer Company

Fig. 7—Sectional view of Bradley Hercules Mill. Provision for automatic lubrication wherever practicable on this mill materially aids in maintenance of low operating temperatures and elimination of lubrication defects.

peratures. On the other hand, since the oil must flood these bearings, it should never be so heavy as to be too resistant to flowing. As a rule, a viscosity range of from 500 to 750 seconds Saybolt at 100 degrees Fahr., will be satisfactory.

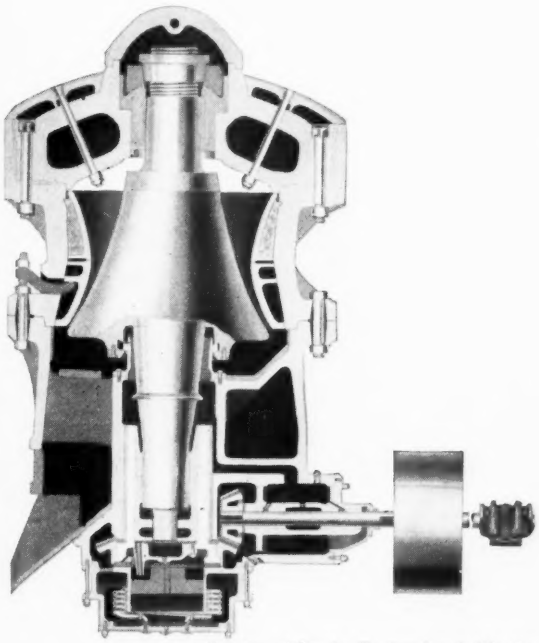
Ring Shaft and Other Bearings

Lubrication of the ring shaft bearings can be accomplished with but little difficulty provided they are kept free from dust or other non-lubricating matter. The maximum speed of the shaft is comparatively low and the load is normally well balanced. These bearings are usually equipped with large openings at the top which may be packed with oil saturated waste or a light grease.

The pinion shaft operates at a somewhat higher speed than the ring shaft, but the same provisions are made for lubrication which allows for usage of the same lubricant.

Gear Sets

The gears of such mills are enclosed and consequently dust will not present a serious problem. In addition, they are not exposed to high temperatures. As a result they can normally be operated in a bath of light gear lubricant. This latter should, of course, possess sufficient adhesiveness to withstand the throwing-off action of centrifugal force.

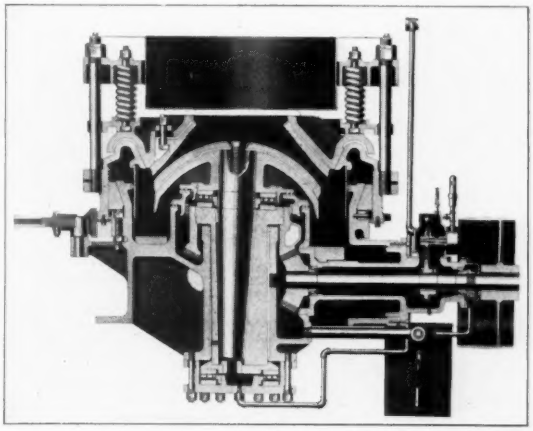


Courtesy of Traylor Engineering & Mfg. Co.

Fig. 8.—Cut-away view of Traylor gyratory crusher, showing automatic lubricating system and coil for cooling or heating of the oil in the base.

Driving Through the Top Hammer Roll

Other types of vertical ring grinders provide for driving of the top hammer roll instead of the ring. This is brought about by means of a pulley, or directly by a motor. The movement of the top roll causes the ring to revolve, to in turn impart motion to the lower rolls.



Courtesy of Smith Engineering Works

Fig. 9.—Sectional view of base of Telsmith Gyrasphere crusher, showing details of the lubricating system at the right and oil piping to and from the crusher elements.

The only points requiring lubrication on such mills are the two bearings on each of the hammer roll shafts. These bearings are long and are fitted with collars for excluding dust. Each bearing is equipped with a large reservoir capable of holding a quantity of grease, which is fed into grooves on the slack side of the bearing. As a rule, no unusual lubricating difficulties will be encountered and a light grease will serve the purpose with perfect satisfaction.

GRINDING OR PULVERIZATION

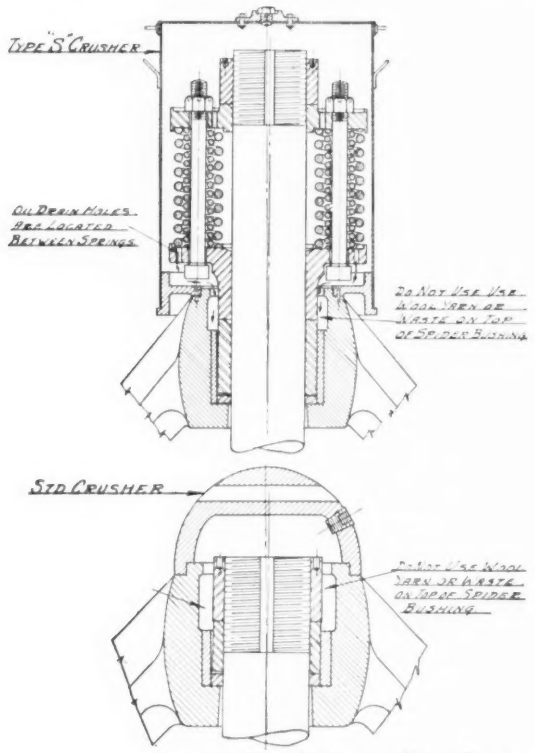
In certain types of industry rock must be broken or ground to greater fineness after it has passed through the primary crushers. Cement rock in particular must be so treated. In fact, in the cement industry the rock must be ground just as finely before burning as after. This is accomplished in ball, rod or compartment mills, which are noteworthy for their high degree of uniform pulverization.

In design, mills of this type involve a horizontal steel drum, partially filled with steel balls or rods. The drum is usually rotated by motor power through a set of enclosed reduction gears. As rotation occurs the balls or rods roll continually to the bottom of the drum, grinding the particles of rock between and beneath them. The tube mill is frequently longer than the ball mill and is capable of finer grinding.

Lubricating Conditions

Any mill which is carried upon horizontal

bearings is difficult to lubricate because of the great weight and the fine grit or dust which may get into the bearings. Every possible precaution is taken, therefore, in the design of the modern mill, to keep this dust out of the bearings, but it always seems to get in somehow


TYPE "S" CRUSHER
OIL DRAIN HOLES ARE LOCATED BETWEEN SPRINGS
DO NOT USE USE WOOL YARN OR WASTE ON TOP OF SPIDER BUSHING
STD CRUSHER
DO NOT USE WOOL YARN OR WASTE ON TOP OF SPIDER BUSHING

Courtesy of Kennedy-Van Saun Mfg. & Eng. Corp

Fig. 10—Top details of a Kennedy-Van Saun type "S" and Standard crushers with instructions for lubrication.

and is frequently the cause of their rapid destruction through abnormal wear.

This is one reason why the bearings are always built large so that the unit loads are not excessive, but in spite of this it is necessary to use a lubricant possessing considerable body in order to prevent undue frictional heat. Inasmuch as such mills revolve slowly, there is, fortunately, no objection to a heavy lubricant from the standpoint of speed. A medium to heavy grease is the most suitable lubricant for these bearings, due to its ability to carry load and prevent entry of foreign matter.

Correction of Overheated Bearings

Overheated bearings will usually be due to the combined cause of presence of abrasive dust and use of an unsuitable lubricant, insufficient lubrication, or because of some mechanical fault, such as poor alignment of the shaft, insufficient clearance, etc.; although where hot materials are being handled, a certain amount of heat may often be transmitted to the bearings.

As soon as serious overheating is discovered, the mill should be stopped if possible. This, however, may not always be practicable in the cement mill. Where such is the case, the troublesome bearing should be loosened and flooded with steam cylinder or crusher oil. At the first opportunity thereafter the bearing should be examined to see that the grooves and oil feeds are not clogged, for very often the babbitt metal may have become sufficiently soft to wipe. At this time any other mechanical faults should be corrected. Afterwards, if the bearing still continues to heat the chances are that lubrication is at fault, in which event the grade of lubricant used and its means of application should be checked.

Trunnion Bearing Lubrication

In cement mill service ball or tube mill bearings of the trunnion type present one of the most difficult lubricating problems, due to the fact that:

1. Heavy loads must be carried.
2. The trunnions often become overheated, on account of their proximity to the shell.
3. Dust and grit may work between the bearing surfaces.

Use of a grease or oil possessing considerable body and a high liquefying point will go a long way in preventing bearing trouble. On the other hand, it is practicable to effect a certain amount of temperature reduction by making provision for cooling water circulation.

Bearings of this type are generally of large size. Furthermore, in view of the fact that all the thrust is downward, due to the weight of the mill and its contents, certain types of bearings are very often lined on the bottom half only; this lining can readily be replaced when worn. Inasmuch as the caps of such bearings carry no lining, they merely serve as dust shields and receptacles for the grease used in their lubrication. Care should always be taken to see that this latter is a carefully refined fibrous grease of high melting point. Where wool yarn packing is desired, however, a lighter grease, or a high grade crusher oil, should be used as the medium for saturation. the wool yarn in this case serving as a seal or strainer to catch dust or dirt.

Self-Oiling Bearings

Considerable study has also been given to the development of means for automatic lubrication, the bearings in this case being of the two-part type, with a cap lined in very much the same manner as a standard type of plain bearing. Oil is carried in a suitable reservoir below the bearing, being distributed by a dipper device, which is rotated by the shaft.

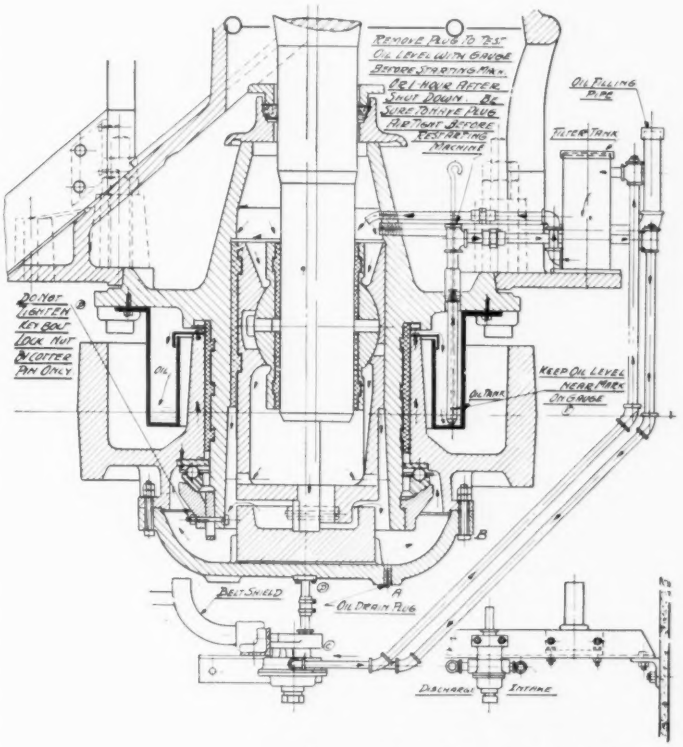
Usual construction is to provide two of

such dippers which at every rotation automatically fill themselves with oil to empty same along the top of the shaft. From this point oil is distributed throughout the entire clearance space. These bearings are normally water-cooled; as a result it is not essential to resort to an extremely heavy-bodied lubricant.

Bearings of this type have also been extended to the more modern designs of trunnions. By reason of their construction, and the ample oil supply available, they insure effective lubrication to a high degree. There is but little opportunity for entry of abrasive foreign matter, and the fact that the bearings are flooded with oil insures that any dust or dirt which may be present will be flushed out from the clearance space by the oil. In the course of circulation, such foreign matter will have an opportunity to settle to the bottom of the oil reservoir during the rest period, from whence it can subsequently be removed at the draining period.

Roller Bearings

The roller bearing has also been adapted to trunnion design, with evidence of being quite as advantageous as the self-oiling plain bearing, although, as a general rule, the roller bearing will not have as ample a lubricant reservoir. Either oil or grease may be used, according to the design and the provisions made for application by the builders.



Courtesy of Kennedy-Van Saun Mfg. & Eng. Corp.

Fig. 11—Eccentric and oiling system on a Kennedy-Van Saun primary crusher. Arrows indicate flow of oil throughout the lubricating system. Other essential parts are plainly shown.

Pinion Shafts

Where the pinion shafts of ball and tube mills are carried by ring-oiled bearings, the most suitable lubricant will normally be a machine oil of from 200 to 300 seconds Saybolt viscosity at 100 degrees Fahr.

Care should be taken to clean out the reservoirs frequently and to add fresh oil to make up for that lost. Most troubles in ring-oiled bearings will be due to the reservoirs being too small to allow the oil to cool properly. When the bearings heat, it is useless to use an oil of higher viscosity, for this will only aggravate the trouble. A better remedy is to increase the capacity of the oil reservoir by tapping a short length of pipe into the lower part and plugging its lower end.

Wick Feed Oiling

A decided advancement in the lubrication of trunnion bearings has been the adoption of wick feed oilers. These latter, by virtue of the fact that they assure more positive lubrication, will render operation more dependable through reduction of bearing wear. This will, of course, lead to reduced maintenance and repair costs.

Wick oilers are particularly adaptable to existing installations, due to their low first cost and the ease with which they can be substituted for more crude means of lubrication.

More attention, however, may be required with such a means of lubrication, for the cups must be refilled with a few ounces of oil about twice daily, whereas with grease lubrication certain cups or boxes will carry sufficient lubricant for a week or more.

Regular examination of such oilers is advisable in order to check any possibility of oil carbonization at the bend of the wick. This will be especially apt to develop on bearings which may be exposed to high external temperatures. Under such conditions, carbonization may impair the flow of oil through the wick to the bearing. It can, however, be corrected by rubbing the wick between the fingers at regular intervals to loosen and remove deposits.

Vertical Mills

Certain mills are also designed for vertical

operation. A distinctive type of such mill employs four balls, which roll around the internal circumference of a wearing ring or die at the rate of about 160 times per minute. Considerable pressure against the die is thereby brought about, for the material is ground between the balls and this latter.

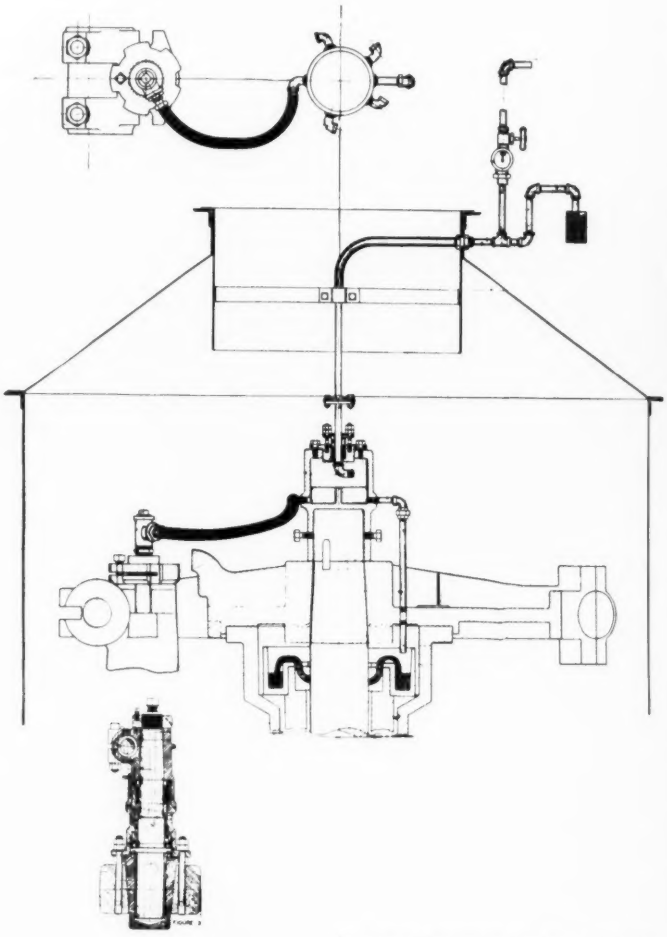
The main shaft bearings of such a mill may be lubricated with either a heavy oil or grease. The intermediate bearing, however, because of its inaccessibility, is most conveniently lubricated with grease. The lower bushing and thrust bearing are arranged to operate in a bath of oil.

Steam cylinder or crusher oil may be used successfully for such lubrication, but when the gear drive and ball thrust bearing are incorporated in the same housing, only lubricants suitable for ball bearing lubrication should be employed.

The driving gears which are used upon some types of such mills, may be successfully operated in a bath of light gear lubricant of about the same viscosity as a heavy steam cylinder or crusher oil. Where grit may get into the gear case, this method of lubrication is not as satisfactory, however, as the use of a more viscous product, ranging up to 1000 seconds Saybolt viscosity at 210 degrees Fahr. The loads on the gear teeth and the dust conditions are usually not as severe as those met with in the gyratory crusher but the temperature in the gear case is usually quite high.

ROLL CRUSHING

Roll crushers may be used either for primary or finishing work. Where crushing of considerable volume of hard rock or ore is necessary, the severe strains which are developed are taken up by heavy duty steel spring assemblies installed in connection with suitable tension rods to counteract any lifting action which may develop in the rolls. Typical construction calls for two hardened steel rolls of size commensurate with crushing to be done. As in the jaw crusher, sleeve type bearings have been found to be most practicable. One roll is normally equipped with fixed bearings, the shafts of the other being mounted in movable bearings to enable a certain amount of play should non-breakable material be present in the rock and pass between the rolls. It has been considered desirable, on certain types of crushers, to mount the movable bearings in sliding pillow blocks, and provide riding plates for the support of the latter. This has been found to improve the flexibility of the entire assembly, reduce friction and wear, and facilitate uniform distribution of pressure over the entire bearing surfaces. Adjustment is also facilitated where change of setting of the rolls is necessary, either to accommodate the type of material being crushed or to compensate for wear.

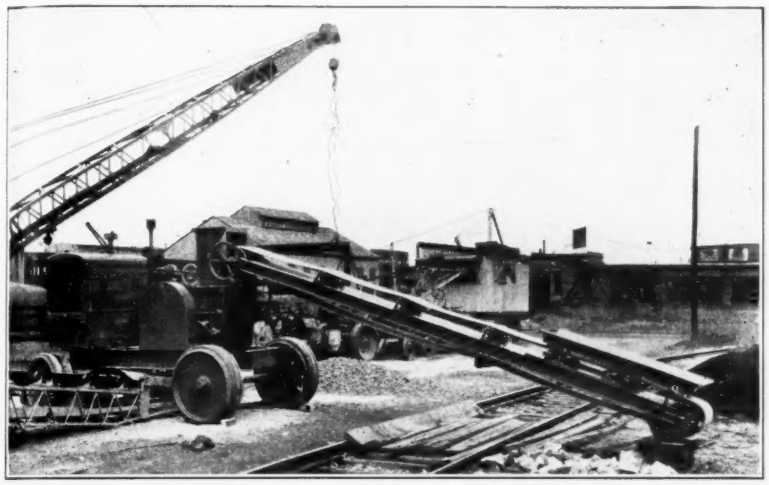


Courtesy of Combustion Engineering Co., Inc. and Raymond Impact Pulverizer Company

Fig. 12—Showing centralized lubricating system for the Raymond Mill. Note piping from storage tank to oil distributing manifold at top of main shaft. From this point oil is delivered under pressure to each oil journal on which the rolls operate. Lubrication of the Raymond oil journal is brought about by the action of centrifugal force on the oil in the space below the bottom of the journal shaft. As the oil passes up and around the journal there is provision for its return to the reservoir for re-circulation.

Screen Design and Lubrication

Screening of rock products to a certain size is frequently necessary after crushing and pulverization. Segregation according to size and fineness is highly essential where the product is to form part of the aggregate in concrete construction. Sizing is also necessary in the manufacture of cement, where all coarse particles of stone must be removed to assure of uniform sizing of the fines. The extent to which screening must be carried out will depend, of course, upon the purpose for which the finished product is intended. In highway construction work, greater leeway is permissible than for building construction, for in road work a small amount of uneven sizes will not materially affect the foundation of the base. In finishing, however, quite accurate screening is obviously essential.



Courtesy of American Pulverizer Company

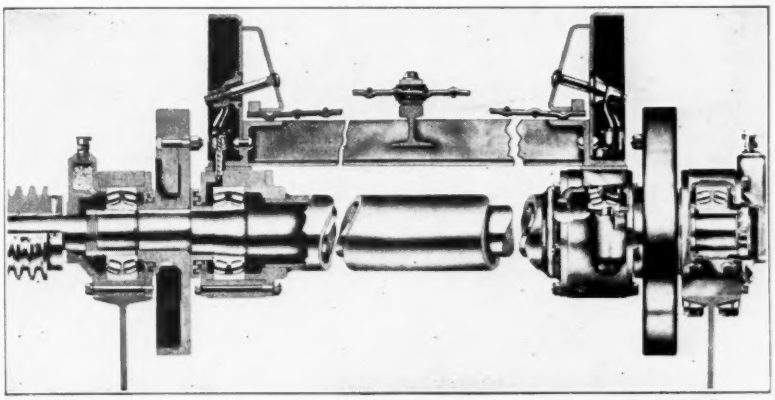
Fig. 13—Showing a portable rock crushing unit complete with automatic feeder. All bearings on crusher as well as the conveyor are equipped for pressure grease lubrication.

The various requirements involved have led to the development of both rotary and vibrating screens. Rotary screens are usually carried on two points of support, one at each end. They are extensively employed in stone quarry service; they consist essentially of one or more cylinders or barrels composed of perforated plates, so located as to afford continuous travel of the product under treatment. The ends, of course, are closed. Suitable bearings or rollers form the supports at each end. Rotation is brought about at the driven end by means of gears, usually of the beveled type, the pinion or driver being keyed to a shaft, which is in turn actuated by an electric motor, chain or belt connection.

Vibrating or shaking screens are extensively used for the separation and classification of finer materials. They bring about the desired result by reciprocating or vibrating action of the frame of the screen fabric with respect to the crushed product, in much the same manner as one would sift ashes by a hand screen. Vibration is usually set up by means of an eccentric mechanism driven by motor, chain or belt power. Screens of this type are generally set on more or less of an angle, the product being screened wet or dry according to the process involved. In the clay working industry wet screening, for example, is extensively used. Normal handling of quarry products, however, calls for dry screening.

LUBRICATION OF ROTARY SCREENS

The mechanism at the driving end of the rotary screen presents the most difficulty from a lubricating point of view, especially in regard to the gears. These latter will frequently operate exposed with their lubricants subjected to contamination by dust, dirt and probably



Courtesy of Link-Belt Company

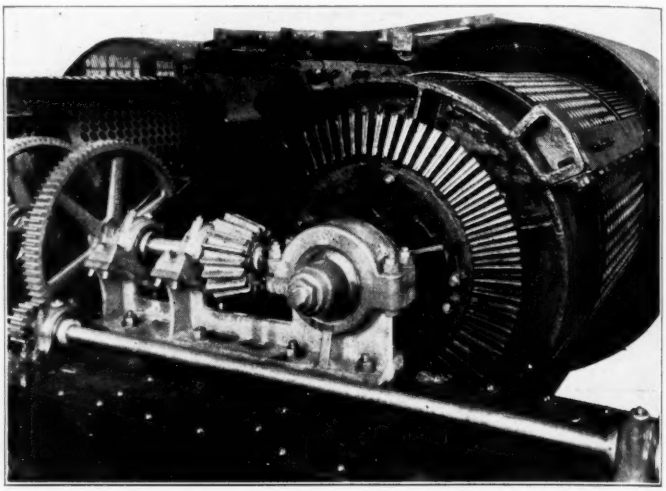
Fig. 14—Showing general assembly and sectional details of the vibrator shaft for a Link-Belt shaking screen. Note that SKF spherical, self-aligning roller bearings are used. These can be lubricated either by individual oilers or by pressure grease gun.

moisture. Also in many cases they may be exposed to wide variations in temperature, which would likewise tend to reduce the efficiency of lubrication, unless the lubricant used has been specially refined to function and protect metallic surfaces under these conditions.

The same applies to lubrication of shaft and support bearings to a certain extent; although the housings, if properly designed and installed, will normally prevent the entry of an excessive amount of dust and dirt. As a rule plain babbitted bearings are employed, with provision for grease lubrication. Under the prevalent operating conditions grease is probably a better lubricant than oil due to its ability to maintain a more effective seal against entry of abrasive foreign matter. It must be a product insoluble in water, however, due to the possibility of its having to withstand the washing action of rain, or any water used during screening. As a rule a cup grease of medium body or consistency will be best suited to these conditions, and capable of ready application by means of some form of compression cup or pressure gun.

Gearing is most effectively protected by using a lubricant which will not only form a protective film to counteract the abrasive effect of dust, dirt, etc., but will function irrespective of temperature, moisture, or weather conditions. This is a broad requirement, one in fact that very few compounded lubricants or greases will meet with any degree of success. Experience has proven that a straight mineral residual product, of fairly inert characteristics, will give the most satisfactory results. Usually a viscosity of approximately 200 seconds Saybolt at 210 degrees Fahr., will adequately serve the purpose, where means are provided to prevent the loss of lubricant through abnormal dripping. On the other hand, high temperatures might require a higher viscosity of say 1000 to 2000 seconds Saybolt.

Some types of heavier lubricants will tend to agglomerate dust, which will ultimately ball up and scale, or be thrown off, leaving the teeth practically exposed. For this reason, the utmost care is necessary in choosing gear lubricants in order to make sure that they are refined to high lubricating and adhesive characteristics, which will render them capable of resisting the effects of centrifugal force under higher speed conditions. Where it is possible to enclose such gears the practice is very advisable. Not only will a housing serve to reduce the extent of entry of foreign matter, thereby promoting better lubrication, but also it will serve as a means of protection for the operator, by reducing the frequency of relubrication, provided the proper grade of lubricant is used.



Courtesy of Link-Belt Company

Fig. 15—Showing driving end of a Link-Belt revolving stone screen. Hyatt roller bearings are installed on the stub shaft, which is carried in a Link-Belt ball and socket bearing housing, designed to allow for packing with grease. The two counter-shafts are equipped with Timken roller bearings. These bearings are equipped with pressure grease gun fittings.

VIBRATING OR SHAKING SCREENS

With screens of this type the vibratory mechanism is somewhat more intricate than the driving gears and bearings of a rotary screen. It may, therefore, develop more potential difficulties in regard to lubrication. Grease lubrication has been found to be very satisfactory for bearing service, affording the requisite protection by preventing the entry of dust and dirt. As a rule, some form of compression or pressure grease lubricating device should be used to insure as nearly positive lubrication as possible. In such equipment a medium bodied grease will be suitable. Where oil is desirable, as on certain types of anti-friction bearings, a medium viscosity straight mineral product will be found suitable.

Cam operations also require consideration. Where cams may tend to run hot, a problem of under-lubrication and abnormal wear of cams and straps may frequently develop. The proper lubricant to counteract such conditions is a high melting point grease of relatively heavy consistency. The lubricating film developed by such a grease is decidedly tenacious and resistant to the thinning-out effects of higher temperatures.

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Waste Pad Lubricated	TEXACO CAR OILS TEXACO PELICAN OIL, OR TEXACO STAR LUBRICANT B
Grease Cup Lubricated	TEXACO CUP GREASE NO. 1 OR NO. 3 TEXACO MARFAK NO. 2, OR TEXACO STAR H GREASE NO. 00
Eccentric and Other Wearing Parts	
Oil Lubricated	TEXACO CAR OILS, OR TEXACO PELICAN OIL
Grease Lubricated	TEXACO STAR LUBRICANT B, OR TEXACO CUP GREASE NO. 1 OR NO. 3 TEXACO STAR H GREASE NO. 00

GYRATORY CRUSHERS

Eccentric Bearings, Gears, Ball Bearings and Countershaft	
Warm Weather Operation	TEXACO PELICAN OIL, OR TEXACO CAR OILS
Cold Weather Operation	TEXACO ALGOL OIL OR URSA OIL
Suspension and Wearing Rings	
At Top of Main Shaft	TEXACO CRUSHER OIL TEXACO STAR GREASES
Grease Lubrication	TEXACO STAR H GREASE NO. 00 OR NO. 1
Roll Journals	
Up to 180° F.	TEXACO MARFAK NO. 1 OR NO. 2
Above 180° F.	TEXACO HYTEX GREASE NO. 5 OR NO. 7

ROLL CRUSHERS, BALL AND ROD MILLS, AND SCREENS

Shaft Bearings	TEXACO MARFAK NO. 2 TEXACO CUP GREASE NO. 3, OR TEXACO HYTEX GREASE NO. 3 OR NO. 5
Ring Oiled Shaft Bearings	TEXACO ALEPH OIL, ALTAIR OIL, OR TEXACO ARIES OIL
Trunnion Bearings	
Wool Yarn Packed	TEXACO CAR OILS OR TEXACO STAR LUBRICANT B.
Otherwise	TEXACO HYTEX GREASES
Thrust Bearings (bath Lubricated)	TEXACO CAR OILS
Gears and Pinions (According to Temperature and Manner of Housing)	TEXACO CRATER COMPOUNDS
Eccentric Mechanisms	
Grease Lubricated	TEXACO CUP GREASES, TEXACO MARFAK, OR TEXACO VEGA GREASES
Oil Lubricated	TEXACO CAR OILS

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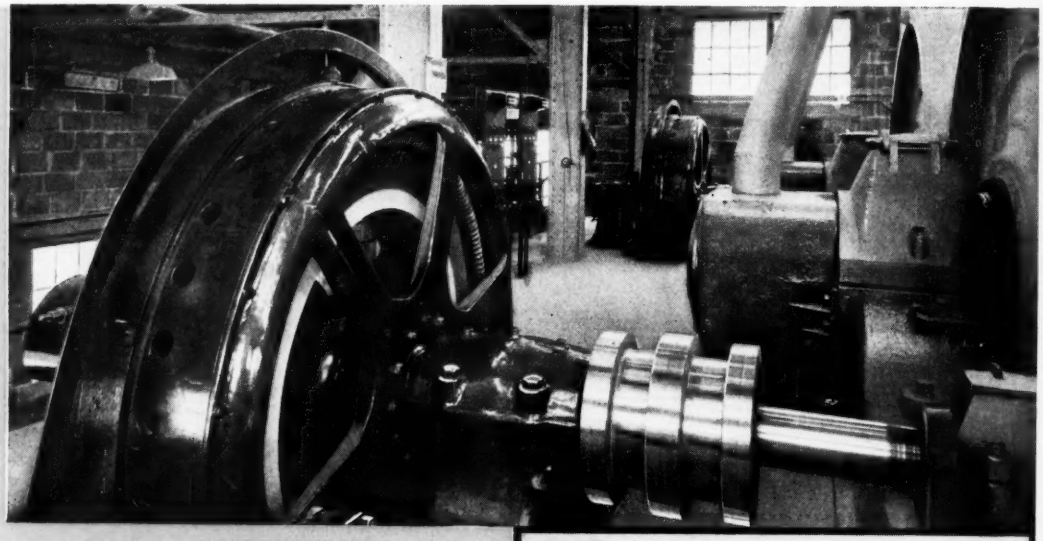

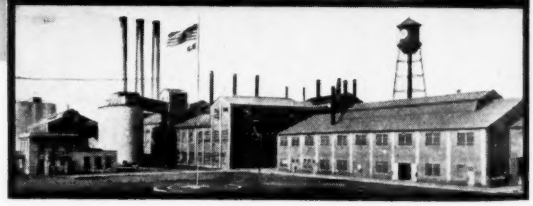

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